3.0 Program Challenges

Like other renewable energy technologies, EGS technologies face perceived institutional and economic barriers, challenges, and obstacles to market penetration including:

- Limited access to transmission infrastructure;
- Lack of available and reliable resource information;
- High exploration risks and high upfront costs;
- Absence of national policy; and
- Complicated siting, leasing, and permitting issues.

The following sections summarize the institutional barriers that the Program must address and overcome in order to increase the development and deployment of EGS. Challenges in resource assessment and data needs are discussed, as are education and workforce development needs.

3.1 Institutional Barriers

3.1.1 Access to Transmission Infrastructure

The ability to transmit electricity from the source to the power grid represents one barrier to expanding the development and deployment of EGS. Geothermal resources are generally remote from load centers requiring investment in transmission infrastructure, which can lead to high delivery costs that may not be competitive with conventional technologies. A large amount of capital is required for transmission expansion providing a disincentive for utilities to build infrastructure to reach remote geothermal sources.

As EGS technologies mature, greater flexibility regarding location will provide an opportunity to develop sites near existing infrastructure to quickly move electricity to the grid. However, expansion of electricity transmission capacity may still be required to connect geothermal energy to the electricity grid.

3.1.2 Lack of Available and Reliable Resource Information

Poor availability of accurate and reliable resource data and information is a significant deterrent to potential geothermal investors. Recent attempts at organizing existing data on geothermal resources in the United States, specifically across western states have done little to improve information quality, since most of the existing information regarding geothermal resources comes from private lands while Federal lands which make up a great proportion of the identified resource.

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To address this barrier, GTP has issued a solicitation for a web-based National Geothermal Database. This database will serve as a central repository of new DOE EGS demonstrations and component research and development data, and provide vital links to historical geothermal data, maps and key international geothermal information centers. This central database will help mitigate risk associated with geothermal energy development. Data organized by using common metrics could assist geothermal developers in identifying and assessing sites with the best geothermal resource potential. Industry comments received during 2008 indicated that a standard financial risk classification system could help provide prospective geothermal investors with the information needed to make the most informed decisions possible on the potential for success at different locations. A well designed National Geothermal Database should link diverse data sources, document data origins, ensure data security, and serve all of the named needs.

3.1.3 High Exploration Risks and High Up-front Costs

EGS has significant upfront costs that must be incurred prior to determining the viability of the resource. This investment requirement raises the stakes for investors who must commit capital without clearly understanding the return profile. The high probability of loss in the early stages of development makes supporting geothermal development through the creation of a novel risk mitigation product very challenging.

EGS must be cost-competitive in order for industry to accept the technology as commercially viable. Drilling deep wells to access the resource is currently not economically feasible. In order for the technology to succeed, costs of drilling deep wells must be reduced, plant efficiency must increase and technology innovation must show significant improvement throughout the industry.

3.1.4 Absence of National Policy

The largest problem facing the geothermal industry is the lack of a Federal policy to promoting geothermal development. The economic viability of most geothermal electricity production projects continues to be dependent on the financial support created by national and state energy policy. Carbon and greenhouse gas restriction policies already have a significant economic impact on projects in other parts of the world and could factor into carbon emissions and trade costs. Policy-based support will be necessary to produce any level of investment in all but a select group of fringe projects.

Two policy implements have potential to significantly influence geothermal development. The Federal production tax credit (PTC) has been the single most important program supporting renewable generation in the United States. The PTC pays 1.9 cents/kWh for electricity produced and sold in the United States, but without reliable, long-term extensions, investors may miss out on this opportunity. The recently enacted Energy Independence and Security Act of 2007 (P.L. 110-140) (EISA) contains several provisions designed to further encourage renewable energy development and deployment in the United States and highlights geothermal energy expansion authorizing $95 million for both conventional and enhanced geothermal research, however, Congressional appropriations have not allowed the program to maximize the potential opportunities afforded by this Act.

Policy continuity and clarity, with respect to the PTC as well as state-based regulatory mandates, will

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provide critical support for geothermal development. In the near term as regulatory programs related to renewable energy and carbon emissions continue to develop and evolve, the continuation of the PTC will be critical to supporting significant investment interest in EGS as clean, secure, and reliable baseload energy.

3.1.5 Siting, Leasing, and Permitting Issues

Most of the geothermal energy facilities in the United States are located on federal lands. The Bureau of Land Management (BLM) has the responsibility for issuing geothermal leases on federal lands and reviews permit applications for geothermal development. Although BLM has the primary authority over leasing, the concurrence of the Forest Service (FS) is required for leases on lands it manages.

Lease nominations are handled by the BLM field office in which the lease occurs. The BLM receives nominations from applicants, which may include proposed tract configurations for parcels. The BLM then, if appropriate, forwards the proposal to the FS, which decides whether or not to consent to leasing and if so, what lease stipulations are necessary to minimize impacts to other resources. Once lease parcels are configured, the BLM is responsible for conducting competitive lease sales and issuing leases.

Source: http://www.blm.gov/wo/st/en/info/About_BLM.html

Figure 3.1. Public Lands States Map from BLM

The Energy Policy Act of 2005 established new procedures for federal geothermal leases. The statute addressed the backlog of geothermal lease applications at that time. One means of addressing the backlog was to call for greater cooperation among the federal agencies involved. The BLM and FS signed a memorandum of understanding (MOU) in 2006. One result of the MOU is that the BLM and FS completed a programmatic environmental impact statement (PEIS) for geothermal leasing in the western United States.[20] The PEIS assesses the direct, indirect, and cumulative effects of leasing, exploration, and development of geothermal resources in order to expedite leasing. The PEIS also amends federal resource management plans and land use plans for geothermal leasing. Site-specific analysis of leasing nominations, permit applications, and operations plans can refer back to the PEIS and best management practices included in the resource management plans, reducing the processing time for leasing and permitting.

Permits and site licenses for geothermal development on federal lands are issued by the BLM. Separate permits are required for exploration, drilling, utilization, and commercial use. The National Environmental Policy Act (NEPA) requires the BLM to analyze the environmental impacts of the proposed geothermal project and then issue either an environmental assessment supporting a finding of no significant impact or an environmental impact assessment. The EIS should contain a discussion of the need for the proposed action, alternatives, and impacts. A draft EIS is published for public comment.

20 http://www.blm.gov/wo/st/en/prog/energy/geothermal/geothermal_nationwide/Documents/Final_PEIS.html

Geothermal projects on state or private lands are under the jurisdiction of state and local regulatory agencies. States are not consistent in how they define geothermal resources or in howsiting and permitting are handled. Mineral rights, water use rights, and environmental laws vary by state. Some states grant power plant siting authority to a public utility commission or siting board. A few of these boards coordinate environmental review and permitting; others leave this in the hands of the developer.

3.2 Resource Assessment and Data Needs

The USGS, the geothermal industry, and DOE have supported a number of studies and data acquisition efforts to obtain exploration-quality near-surface temperature information with reduced costs and drilling time. The net result of multiple studies is that properly corrected shallow temperature data may provide an exploration quality outline of a resource area and may substantially reduce the number of deeper temperature gradient holes required to evaluate the resource prior to drilling exploration wells. A large amount of temperature gradient and heat flow data has been made available through two national online databases: the Global Heat Flow Database of the International Heat Flow Commission, provided by the University of North Dakota;[21] and the Southern Methodist University (SMU) Geothermal Lab Heat Flow - A Transfer of Temperature Database.[22] Through state cooperative programs, DOE drilling projects have resulted in public temperature gradient/heat flow databases.[23]

The following geothermal resources maps of the United States illustrate the estimated subterranean temperatures at depths of 3.5, 6.5, and 10 km.

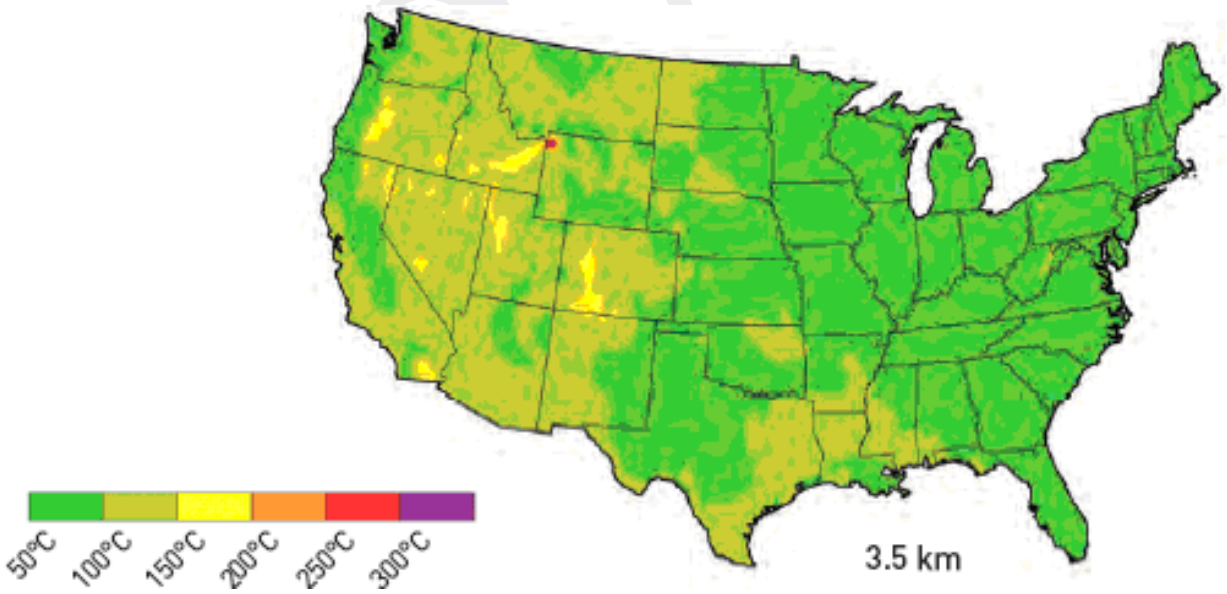

Figure 3.2. U.S. Geothermal Resource Map at 3.5 km[24]

21 Geothermal Heat Flow Database of the International Heat Flow Commission: http://www.heatflow.und.edu/index2.html
22 SMU Geothermal Lab Heat Flow–A Transfer of Temperature Database: http://www.smu.edu/geothermal/heatflow/heatflow.htm
23 A History of Geothermal Exploration Research in the Geothermal Technologies Program, p. 69, U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy, Geothermal Technologies Program
24 "The Future of Geothermal Energy, Impact of Enhanced Geothermal Systems (EGS) on the United States in the 21st Centry,"

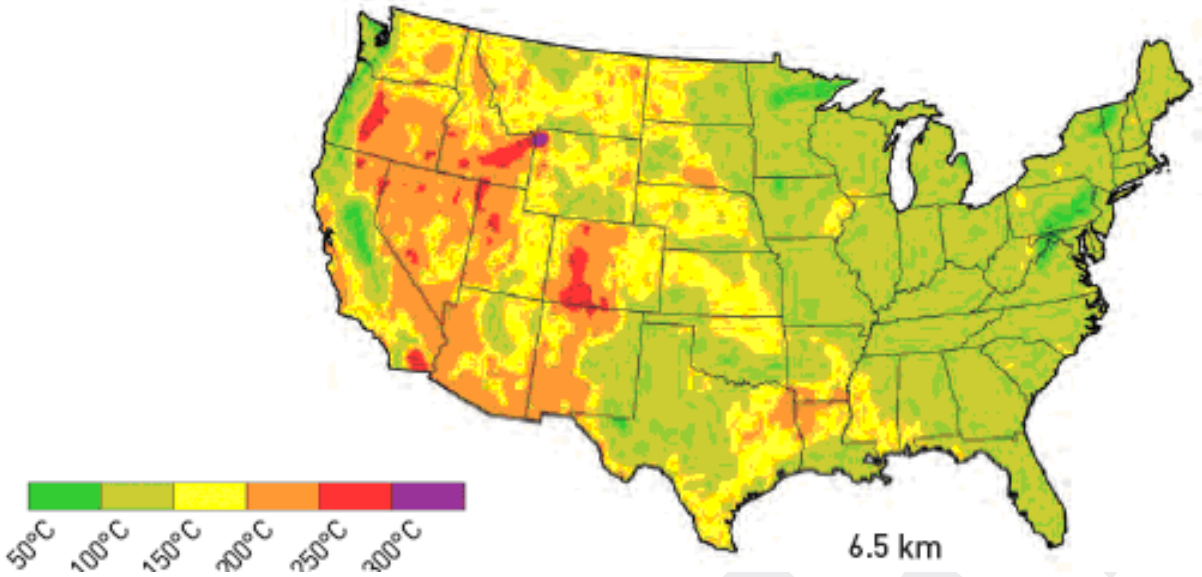

Figure 3.3. U.S. Geothermal Resource Map at 6.5 km[25]

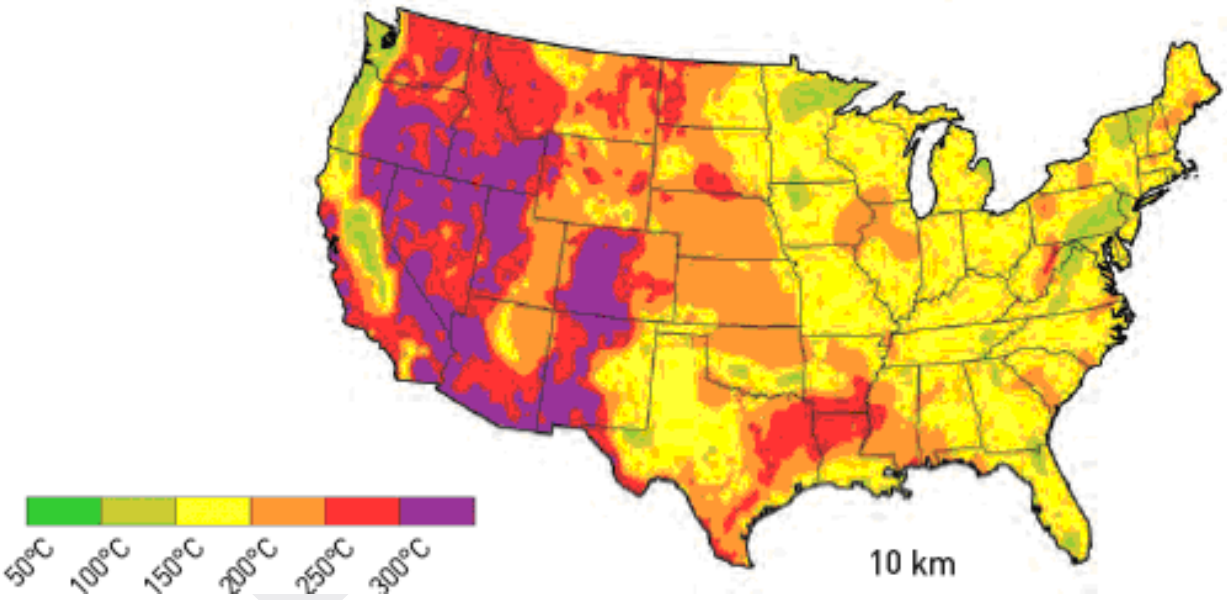

Figure 3.4. U.S. Geothermal Resource Map at 10 km[26]

Massachusetts Institute of Technology, 2007.

25 The Future of Geothermal Energy, Impact of Enhanced Geothermal Systems (EGS) on the United States in the 21st Century," Massachusetts Institute of Technology, 2007.

26 Ibid.

Resource Assessment: DOE's National Geothermal Action Plan discusses work underway by the U.S. Geological Survey pertaining to resource assessment.

Data Needs: Analysis shows that there are many geothermal databases available satisfying different purposes and needs. There is not, however, a unified national standard or infrastructure capable of storing or linking comprehensive subsurface data sets. A web-based National Geothermal Database will serve as a central repository to house new DOE EGS demonstrations and component research and development data. The database will also provide vital links to current and historical geothermal data and maps throughout the United States and key international geothermal centers. This central repository for critical national geothermal data will help mitigate risk associated with geothermal energy development.

Data will be organized using a set of common metrics such that criteria useful in assessing and identifying sites with the best geothermal resource potential can be defined. The database will include a standard financial risk classification system in order to provide geothermal prospectors with the information needed to make informed decisions on the potential for success at different locations via an overall favorability index.

3.3 Education Workforce Development

The establishment of a program that includes geothermal curriculum, student exchange, and training/internships is key to ensuring development of the geothermal market. An educated and trained workforce is needed to meet the expected and hoped for industry growth. Incorporation of geothermal curricula into trade schools and higher education programs is necessary. A student exchange/scholarship program would help transfer technology to the United States as would an internship/training program. Curricula must be developed in geology, drilling technology, exploration and characterization technologies, reservoir management/enhancement, power plant operation, power transmission, and other key geothermal technology areas of development where training programs do not exist.

A professional education program could include:

- **Geothermal Educational Curriculum** at the undergraduate or graduate level with a dedicated geothermal curriculum. The curriculum could be in the form of a full degree program, a minor, or a set of classes with a geothermal emphasis.
- **Student Exchange/Scholarship Program** – A domestic and/or international student exchange/scholarship program is needed as either part of the curriculum or as an additional program that is developed.
- **Training/Internship Program** – A domestic and/or international training/internship program is needed, either as part of the curriculum or as an additional program. Students require practical experience working in the geothermal industry through internships and cooperative programs to gain hands-on experience in parallel with their education. Student participation and teaming with U.S. geothermal companies are critical to ensure adequate geothermal workforce development and training.

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